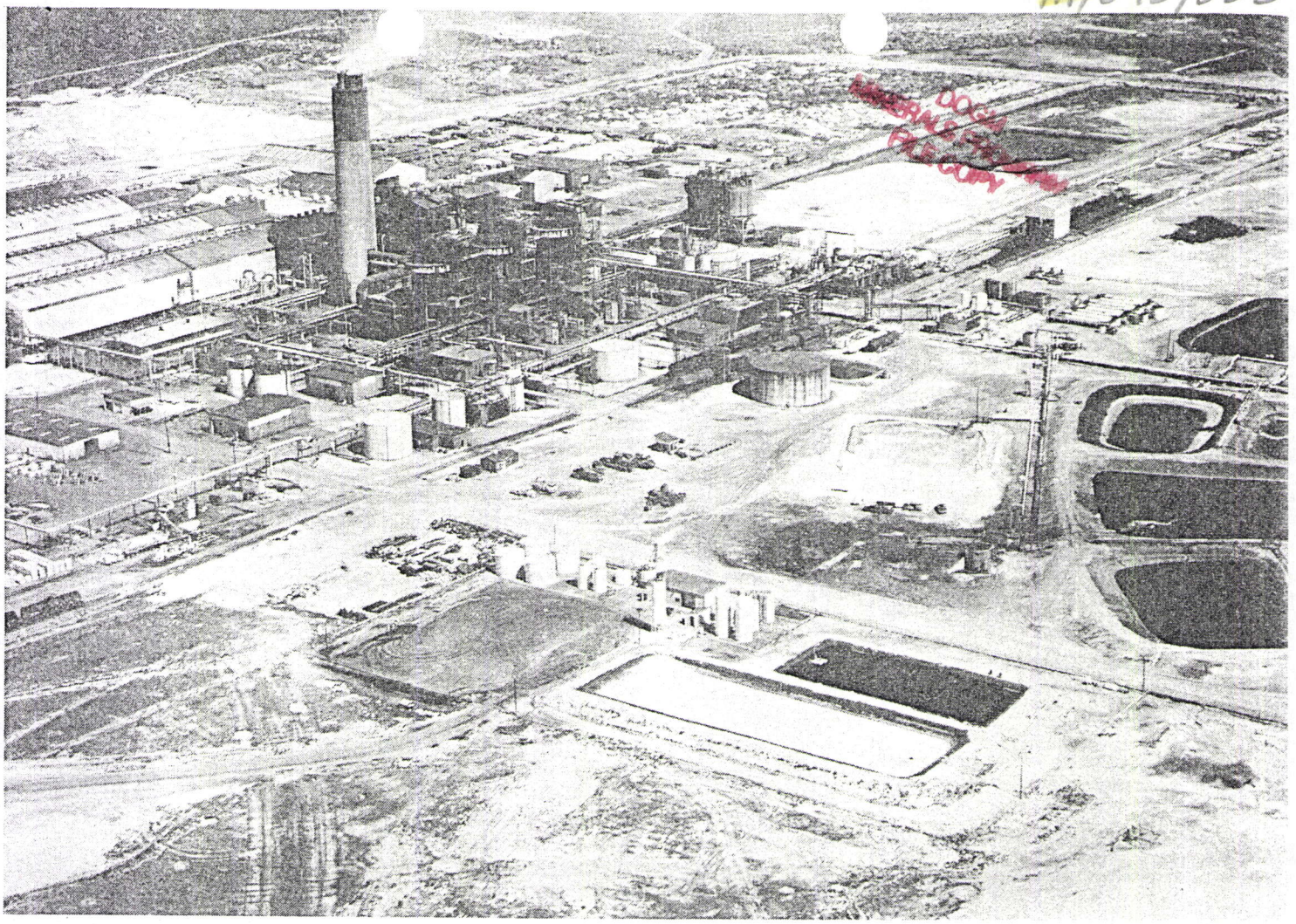



This aerial photo of Magcorp's magnesium plant shows the line of spray dryers immediately to the right of the stack.

# At 34,500 tpy, Magcorp is third largest producer

## Magnesium demand is growing steadily in amazingly broad range of uses

By Bill Hawes
Field Reporter

Magnesium Corporation of America, a little-known Utah company that "mines" the Great Salt Lake, is responsible for producing about 13 percent of the Western world's magnesium.

Known as Magcorp, it is the second-largest producer of this metal in the country and third-largest in the world.

The largest non-government employer in Tooele County, it is a cornerstone of the county's economy, especially in light of the uncertain future faced by 2 nearby military installations.

During the 1960s, National Lead (later known as NL Industries) canvassed the United States for a magnesium source. The search led to the Great Salt Lake, whose brines presented an opportunity for magnesium extraction.

Not only did Utah offer a favorable industrial climate, but there was a virtually inexhaustable supply of magnesium in the lake brines and abundant, reliable and reasonably priced electric power, both necessary for production of the metal.

During the middle to late part of that decade, a consortium of NL, the Hogle-Kearns interests (pioneer Utah miners) and Hooker Chemical did pilot work on extraction of magnesium from the lake brines.

Eventually, NL bought out the other 2 members of the consortium.

Construction of the plant started in 1969 and was completed in 1972.

### First technology didn't work

Initial operation proved disappointing and it was realized that the wrong technology had been employed. So, in 1974, the operation was shut down, the plant retrofitted and the technology upgraded.

After the retrofit, production started in 1975 and built up to reasonable levels in 1977.

In November 1980, NL Industries sold its magnesium business to Amax Specialty Metals, which operated as Amax Magnesium. Amax operated this enterprise through record high levels of the Great Salt Lake and sundry other problems, such as breached dikes.

In August 1989, Amax sold the magnesium business to a private group, RENCO, which has owned and operated the magnesium plant since then under the Magcorp name.

While the process change and retrofit that took place in 1974-75 solved the process problems, other glitches have since occurred — chiefly breaks in the dikes which surround the company's solar evaporation ponds that concentrate the brines.

Dikes broke in 1983 and again in 1986, when the lake was reaching record high levels. (This increase in the lake's volume also greatly diluted concentration of minerals in the water. The lake has been famous for its ability to enable a person to float like a cork; during the record water levels, the water

would no longer give super-bouyancy.)

After the lake reached record levels, a 6-year drought returned the water to its usually high salinity and "normal" levels.

### Troubles begot opportunity

About the time the second dike break occurred, the high lake level demanded government attention. This because Salt Lake International Airport runways were threatened, as were other facilities near the lake, such as oil refineries, wetlands and Interstate 80.

The state intervened, installing and operating huge pumps that lifted lake water into the west desert near Wendover.

Amax Magnesium did not lobby for this action, but after the state decided on the program and ordered the pumps, the company realized it could use flood control action to collect brines in the desert.

About 66,000 acres of land near Knolls (in the western part of the desert) were leased and solar ponds were constructed to collect and concentrate by evaporation the brine being pumped by the state.

The result is that Magcorp now has solar ponds for both high and low lake levels, ensuring a constant source of feed for the plant and a secure supply of magnesium metal and byproduct chlorine for the market.

After the solar ponds were rendered useless by dike failures, production was maintained by importing tank cars of brine from Leslie Salt in the San Francisco area and by purchasing brines from Kaiser Chemical (now Riley Tar and Chemical) at Wendover.

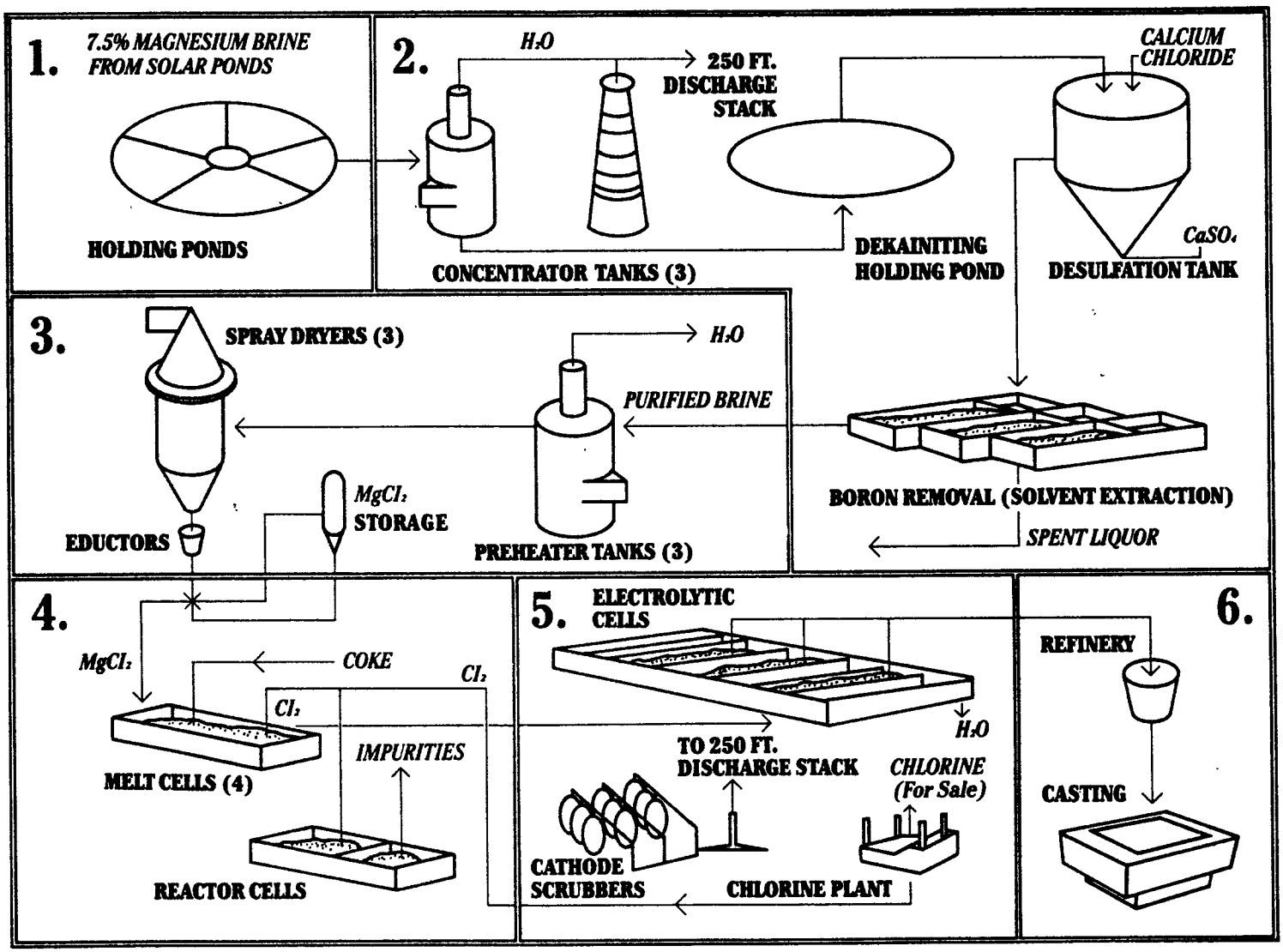
Waters of the Great Salt Lake, once considered useful only as a source of salt, contain a variety of useful minerals: salt, potassium, lithium, boron and magnesium.

The lake water contains about 0.4 percent magnesium, 4 times the concentration of magnesium in the ocean.

### Concentration is first step

The first step in producing metal from the water is to concentrate the brine. This is done by solar evaporation, which increases the

## MAGCORP'S SIX PART PROCESS OF MAGNESIUM




*Magnesium Corporation of America (MAGCORP).*

The extraction of the magnesium from the lake brine is a 6-part process: 1) Solar evaporation to increase magnesium chloride concentration in the brine; 2) Brine preparation to further concentrate magnesium chloride in the brine and remove unwanted impurities; 3) Dehydrating the brine into powder form; 4) Melting the magnesium chloride powder and further purification; 5) Separating the magnesium chloride into magnesium and chlorine by electrolysis; 6) Casting the metal into ingot shapes.

## Magcorp . . .

magnesium concentration to about 7.5 percent. (Note the flowsheet.)

Next, the concentrated brine is pumped into holding ponds. (Step 2 on flowsheet.) These ponds are quite large, holding about a 2-year supply of raw material ready for processing.

The brine is purified by mixing it with liquid calcium chloride. This chemical is produced by taking locally mined oolitic sands (composed of a granular clacium carbonate) and mixing it with byproduct hydrochloric acid.

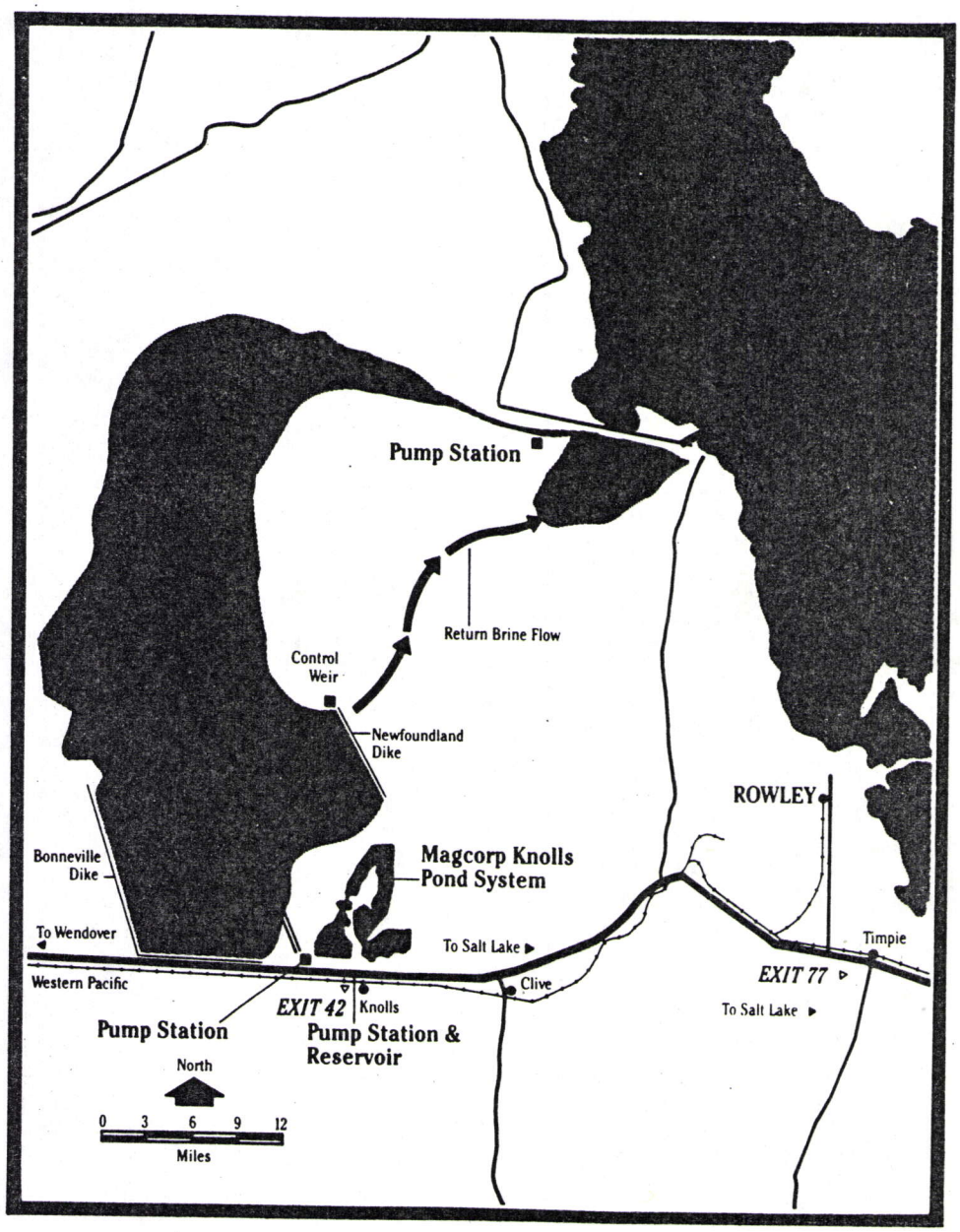
This mixture forms water, carbon dioxic and calcium chloride used for processing. The liquid calcium chloride is mixed with concentrated brine, reacting with the contained sulphates.

Gypsum precipitates and is removed by a thickener. Surplus calcium chloride is sold to a chemical company for resale.

The last step of the brine purification is using solvent extraction to remove boron. (This boron is in dilute form and is discarded into a NPDES-approved pond.)

The purified magnesium chloride solution is next piped (Step 3) from the holding ponds

Magcorp's magnesium plant draws its feed from the Great Salt Lake.




***Magnesium Corporation of America***
*Production Facility: Exit 77*
*Solar Ponds: Exit 42*

.nto 1 of 3 giant towers, where the purified brine is sprayed and flash dried (at about 950 degrees F.) into magnesium chloride powder with a purity of about 82 percent.

Heat is provided by natural gas or fuel oil. Cogeneration of electrical power for plant use takes place along with the drying of the magnesium chloride, using some of the heat.

The powdered magnesium chloride is recovered and stored in 500-ton-capacity bins.

The steam from this operation is vented via an unusual stack, which basically combines 6 stacks into 1. Steam is the most visible evidence that the plant is operating.

Next (Step 4), the magnesium chloride powder is transferred to metal cells where it is melted and purified, using chlorine and other chemicals to remove magnesium oxides and other trace impurities and remaining water. The chlorine used here is recycled byproduct from the next step in the process.

The fifth step consists of transferring the molten magnesium chloride to electrolytic cells, where electrolysis produces magnesium metal and chlorine gas.

### Refining is a different world

To one used to copper refineries, the world of magnesium refining is a totally different experience. The anodes used are made of graphite; the cathodes, of steel.

The molten magnesium chloride in the electrolytic cells is at a temperature of about 1,350 degrees F. A peek into the cell shows red molten magnesium chloride with silvery molten magnesium floating on top.

The molten magnesium is removed from the electrolytic cells with a vacuum wagon that transports it over to the casting facility (Step 6).

The chlorine gas collects at the anode. It is transferred under vacuum to the chlorine plant. Here it is cleansed, purified and dried either for reuse (in Step 4) or for sale.

The electrolytic cells last from 500 to 1,000 days before being relined with brick.

Perhaps the most striking difference between copper operations, familiar to most readers, and magnesium, is that there is no metal deposited on the cathode and the electrolite is a molten metallic salt.

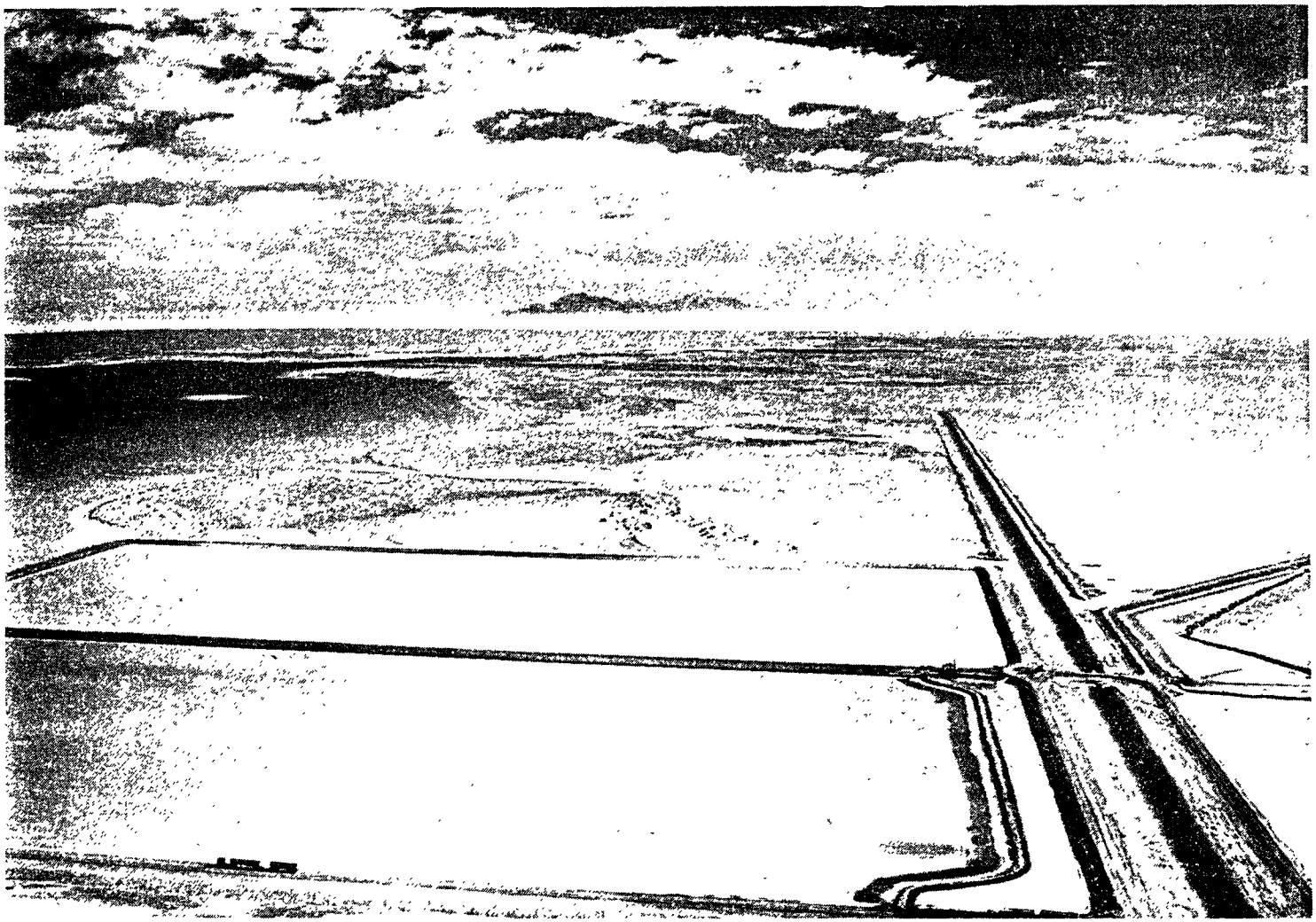
Impurities (referred to as "smut") do not rise to the top, as in most smelting operations, but sink to the bottom of the cells. These impurities are manually removed (or mechanically, in some of the newer cells) about once a week.

The magnesium floats to the top of the cell, where it is collected.

The casting operation (Step 6) further refines the magnesium and casts it into ingots, which weigh from 15-750 pounds, depending on customer specifications.

The cast magnesium shapes are subject to a final visual inspection, prior to shipment. Rejects are melted and reprocessed.

Most output is pure magnesium, greater



In these solar evaporation ponds, the lake brine is concentrated 20 times, to about 7.5 percent magnesium chloride.

## Magcorp . . .

than 99.9 percent purity. There is increasing production of ultra-high-purity metal as well as high-purity alloys and other specialty products.

The finished product is deceptive to one unfamiliar with the metal. A 25-pound ingot of magnesium shines brighter than silver and is about 18x6x4 inches, revealing its specific gravity of 1.74.

### A metal of many applications

The uses of magnesium are truly amazing. No doubt the examples of its use with which most of us are familiar — flares, fireworks, Porche automobiles, etc. — are actually among its lesser uses.

Surprisingly, the major consumer of magnesium today is the beverage industry. Without magnesium alloyed with the aluminum, the beverage can as we know it today wouldn't be possible.

Aluminum alloyed with magnesium is also used in aircraft, automobile and marine applications.

The second-largest use of magnesium is in the steel industry, desulphurizing virtually all steel produced in the United States and about two-thirds of that in Western Europe.

Now that the Iron Curtain has collapsed, the Eastern European steel industry becomes a major potential market for this technology as well.

Advantages of magnesium desulphurization over the calcium carbide method, still is use in other areas, is that it both speeds the process and allows production of higher-quality, lower-sulphur steels.

Currently, the third major market area for magnesium is in structural components, as high-purity alloys. Since magnesium is lightweight, it is in growing demand in the transportation industry to reduce weight of cars, aircraft and trailers. Magnesium alloys also offer improved corrosion resistance.

Magnesium also is used widely in quality cameras, tools, computers and sporting goods.

It is estimated the use of magnesium in structural applications could increase 10-15 percent annually in the United States.

All of these uses of magnesium are expected to be areas of great potential growth.

Other applications for the metal include production of ductile iron, titanium, hafnium, zirconium, pharmaceuticals, perfumes, exotic batteries, flares and pyrotechnics. It also has applications in cathodic protection.

### Dow Chemical largest producer

The largest producer of magnesium is Dow Chemical Company, with the capacity to produce 108,000 metric tons a year from ocean water at its Texas plant.

The second largest is Norsk Hydro, with 2 plants (Norway and Canada) that have an aggregate capacity of 95,000 mtpy.

Magcorp is the third largest, with a nominal annual capacity of 34,500 metric tons.

It is interesting to note there are only 12 magnesium operations in the Western world. Many of these are captive plants. That is, operations whose output is committed to a larger operation, such as Alcoa Aluminum Company's subsidiary, NorthWest Alloys, a

## Magcorp . . .

producer in Washington state which uses the thermal process.

While much magnesium is produced from seawater and brines, it also can be produced from magnesite or dolomite.

Magcorp has received some bad press recently from various environmental groups despite the fact it, as well as its predecessor companies, have always operated within regulatory limits of the Environmental Protection Agency and the State of Utah.

### Hammered on about chlorine

One of the most recent charges is that Magcorp is the largest single point source of chlorine in the country. This is true, but it still is within the limits mandated by Utah and represents only 7 percent of the chlorine emitted by all sources in the country, including water treatment plants and swimming pools.

The issue of dilute cholorine emissions becomes somewhat less significant when one looks at the plant location, at Rowley in Tooele County, a remote, unpopulated area along the Great Salt Lake, slightly more than 10 miles north of Interstate 80.

The closest town is 25 miles away, with the major population centers at least 40 miles from the plant.

Despite these facts, Magcorp has committed to improve the environment and has made major capital expenditures in the last 3 years resulting in a 45 percent reduction in emissions. (This constituted the largest reduction of emissions of any type in Utah last year.)

A bald eagle, seen by this reporter perched on a utility pole a couple of miles from the plant, offered good evidence the operation doesn't harm the environment.

Members of Magcorp's work force of about 550 live over a wide area, both in Tooele County and along the Wasatch Front, in Ogden, Salt Lake City and Provo.

Magcorp provides bus service or van pools from several pickup points for its employees, thus reducing commuting expense and emissions from the large number of vehicles that otherwise would be required.

### Chlorine a valuable byproduct

In addition to having a nominal annaul capacity of about 34,500 metric tons of magnesium, Magcorp sells 10,000 to 20,000 tons of byproduct chlorine for water purification or for use in gold processing.

As mentioned previously, some byproduct calcium chloride is sold to a chemical company.

Magcorp's process produces about 3 pounds of chlorine for each pound of magnesium metal. Much of this is used within the plant, in production of calcium chloride or in purifying the magnesium.

Chlorine that can't be used or sold is burned in a chlorine reduction burner, with the resulting hydrochloric acid neutralized to calcium chloride.

The Magcorp operation is Utah Power Company's largest single customer, using about 3 percent of the utility's electrical output. That's about the same amount used by the city of Provo.

Access to the Magcorp plantsite is by a paved county road that connects with Interstate 80, and by a spur of the Union Pacific railroad.

One unusual feature about the operation is the work schedule at the Rowley facility. Rather than working 3 8-hour shifts a day, 5 days a week with rotating shifts, Magcorp crews work 12-hour shifts (noon to midnight) for 3 days, then are off for 3.5 days, returning to work for 3 more days, on the midnight to noon shift.

This has been a very popular program, as the workers have a long weekend every week.

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*(Editor's note: Bill Hawes expresses his appreciation to Magcorp for generous help with this article. Lee Brown, vice president of human resources, and Dr. Howard Kaplan, vice president of sales and marketing, reviewed the article for accuracy. The technical staff at the Rowley facility gave an excellent tour and explanation of the process, Hawes reports.)*

# Great Salt Lake produces minerals, taxes and big payrolls

**By Bill Hawes**
**Field Reporter**

America's "Dead Sea," the Great Salt Lake, is often viewed as a smelly and ugly lake by those that speed along Interstate 80 between Nevada and Salt Lake City.

Actually, while the lake at times does have a disagreeable smell (caused by decaying vegetation and dead brine flies) and is devoid of vegetation along its shoreline, except where fresh water enters, it supports an amazing amount of wildlife, recreation and industry.

The Great Salt Lake is a remnant of prehistoric Lake Bonneville, a giant freshwater lake that was 1,000 feet deep and covered major portions of Utah, Idaho and Nevada.

The old shorelines of Lake Bonneville are evident along the mountains. Often, this old shoreline is the location of extensive sand and gravel deposits.

About 14,500 years ago, a natural dam in Idaho eroded, allowing the lake to drain. The result was that over the next 4,500 years, the lake fell from an elevation of 5,090 feet above sea level to its present level, which fluctuates from 4,200 to 4,212 feet above sea level.

During the mid-1980s, when it appeared the lake would continue to rise and cause irreparable damage, the State of Utah purchased pumps to transfer the rising lake waters to the western part of the old lake bottom.

While often criticized by his detractors, former Governor Norm Bangerter's action helped save the minerals extraction operations, plus prevented the flooding of large areas of fresh water wetlands along the lake's edge, saving the habitat of several varieties of migratory birds.

The economic benefit of this action is obvious — salt production from the lake has increased to 1.6 million tons a year in the early 1990s, compared with 1 million annual tons a decade earlier.

Also, if one looks at the $60 million expenditure made by the state, and the state taxes of $4.5 million a year paid by just 1 company (Magcorp), plus those paid by others, it can be seen that it was a wise decision by the governor.

Industry supported by the lake varies from the harvest of brine shrimp and their eggs (the shrimp are used as fish food — the eggs are hatched and the resulting brine shrimp are fed to shrimp raised in commercial fish farms) to the extraction of minerals.

Mineral extraction from the lake, including magnesium, salt and potash, provides employment for more than 1,000 people and provided the state with royalty revenues of $930,408 in 1991, according to information published in a recent issue of *The Salt Lake Tribune*.

Further evidence of the economic importance of the lake's minerals extraction is that 1 company alone, Magcorp, pays about $4.5 million a year in state taxes and spends another $20 million for wages and purchases.

## Of Mines And Men

### May build auto racetrack on old steel plant site

Kaiser Steel Resources Inc. said it plans to develop a 360-acre auto racetrack complex on the site of its old steel mill at Fontana, California.

The company said it signed a letter of intent with Agajanian Prime Ventures, a private partnership of auto racing promoters and developers, as part of its plan to redevelop the 1,175-acre site.

Kaiser President Daniel Larson said the partners expect to take 12 to 18 months to design and obtain permits for the complex and an additional 12 to 18 months to build it.